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H04L 29/06

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H4P PPEC

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(54) Connecting RS-485 local area networks to other communications networks

(57) The apparatus (13) connects, via a communication system having at least one communication device 16, an RS485 local-area network to at least one other network. The apparatus includes a modem (15) for transmitting and receiving data messages and an interface (14) for interfacing the modem (15) to the communication system. The interface includes: a first input and a first output for, in use coupling the interface (14) to the modem (15), a second input and second output for coupling the interface (14) to the communication device (16), a buffer means (46,53) to generate a request to send (RTS) message to the modem (15) and a delay means (42,43) to simulate a clear to send (CTS) message for the modem (15).

This allows the connection of an RS485 network to another network because the necessary modem commands request to send is generated and clear to send is simulated.

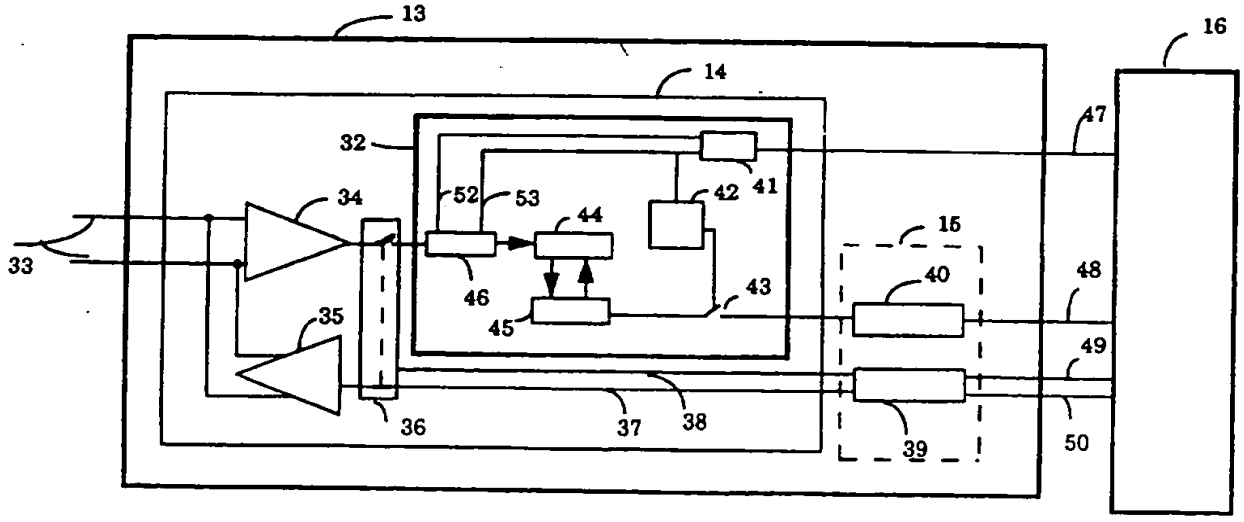

FIG. 2

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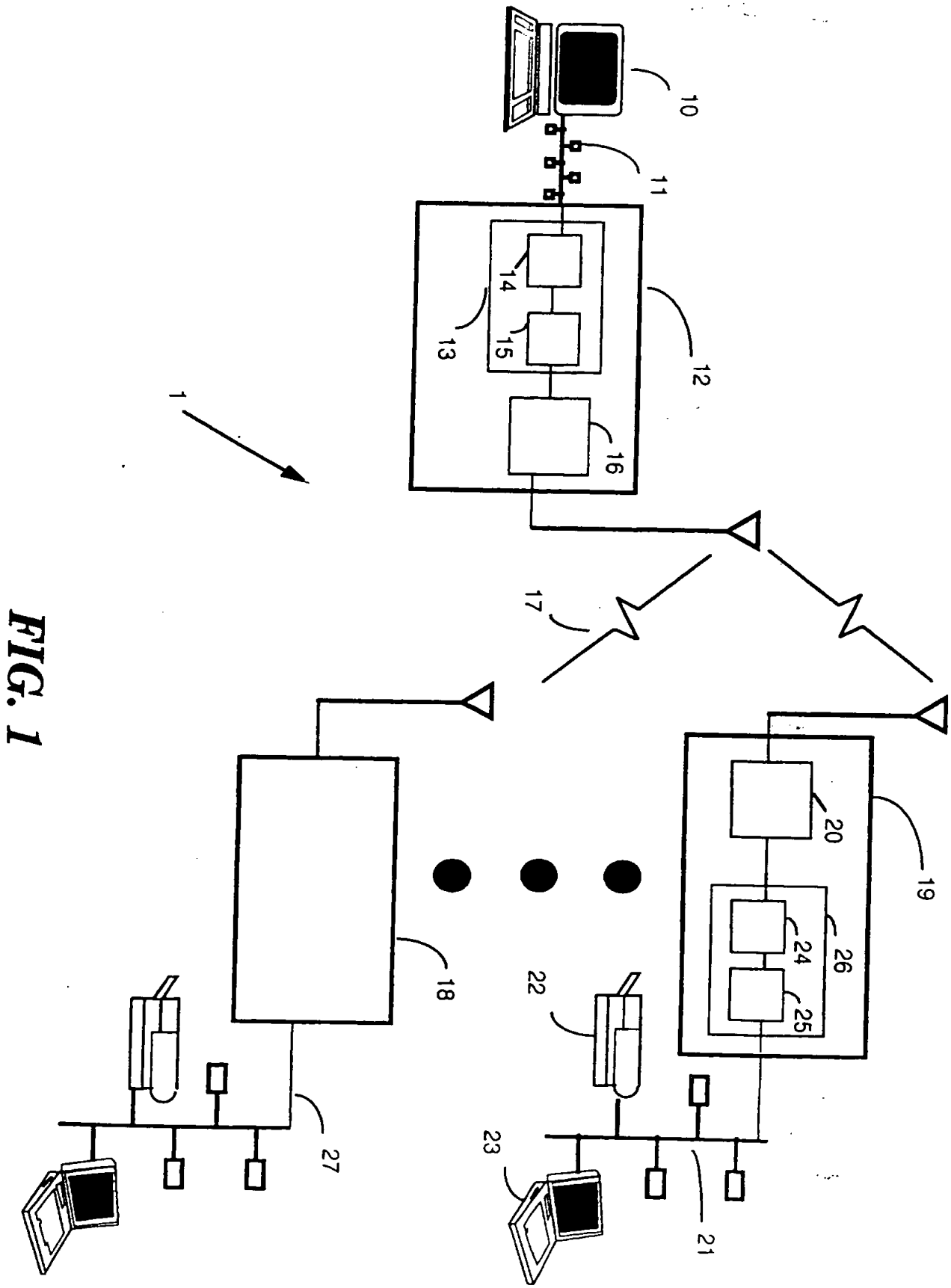

FIG. 1

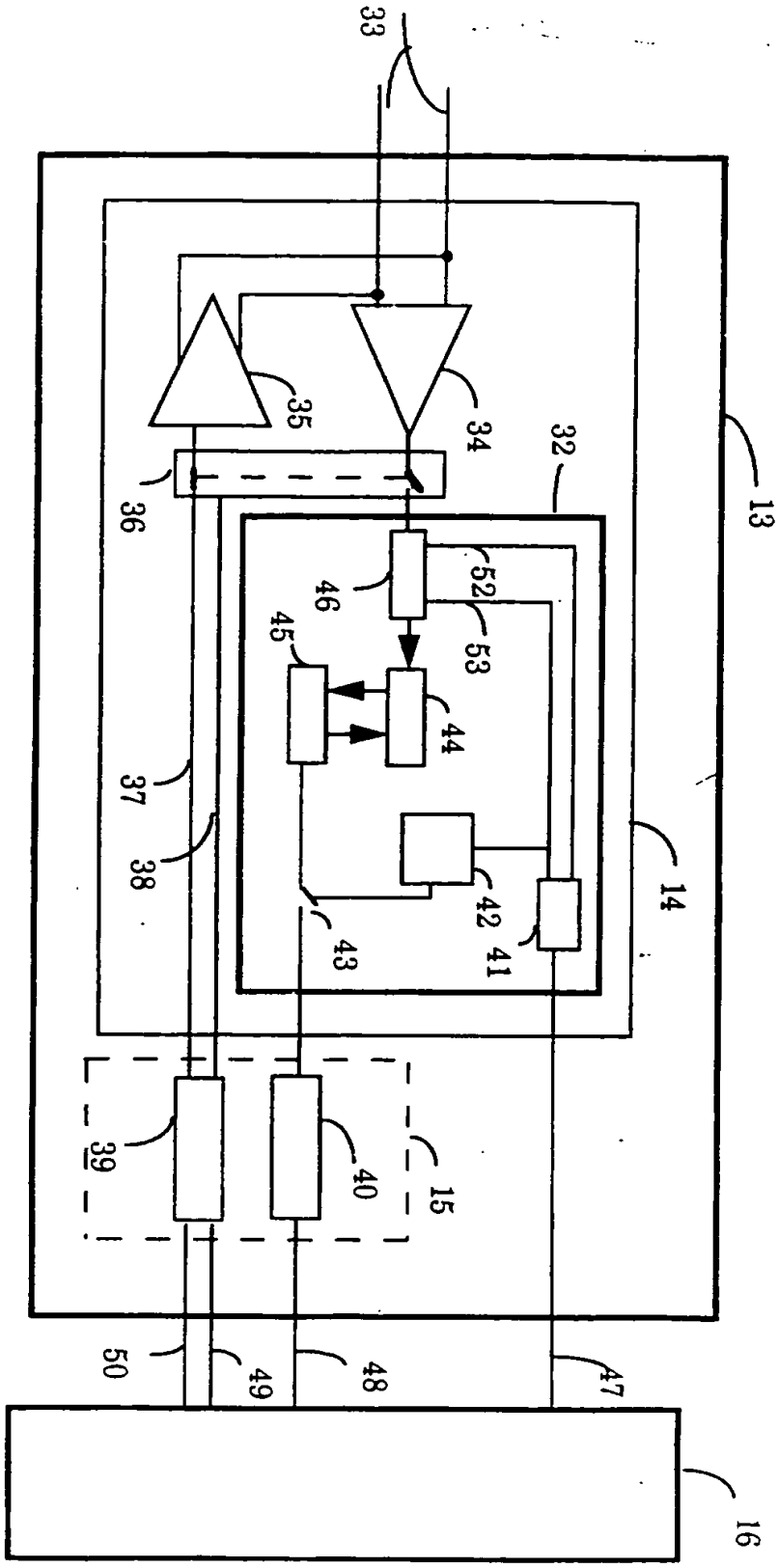
33
35
34
32
13
36
52
46
53
45
44
37
38
42
41
14
43
39
40
15
50
49
48
47
16

FIG. 2

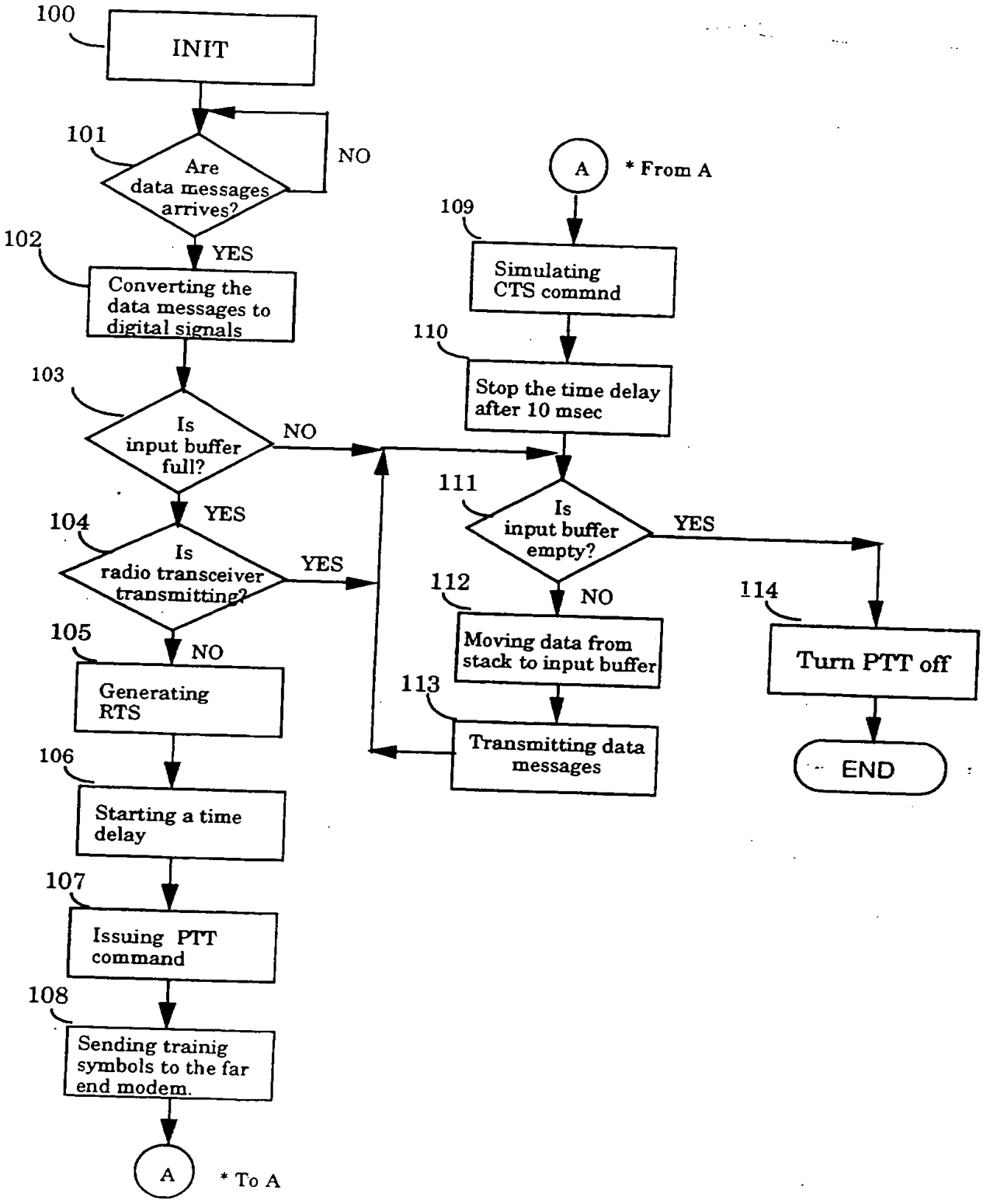
100
INIT
101
Are data messages arrives?
NO
YES
102
Converting the data messages to digital signals
103
Is input buffer full?
NO
YES
104
Is radio transceiver transmitting?
YES
NO
105
Generating RTS
106
Starting a time delay
107
Issuing PTT command
108
Sending trainig symbols to the far end modem.
A
* To A
A
* From A
109
Simulating CTS commnd
110
Stop the time delay after 10 msec
111
Is input buffer empty?
YES
NO
112
Moving data from stack to input buffer
113
Transmitting data messages
114
Turn PTT off
END

FIG. 3

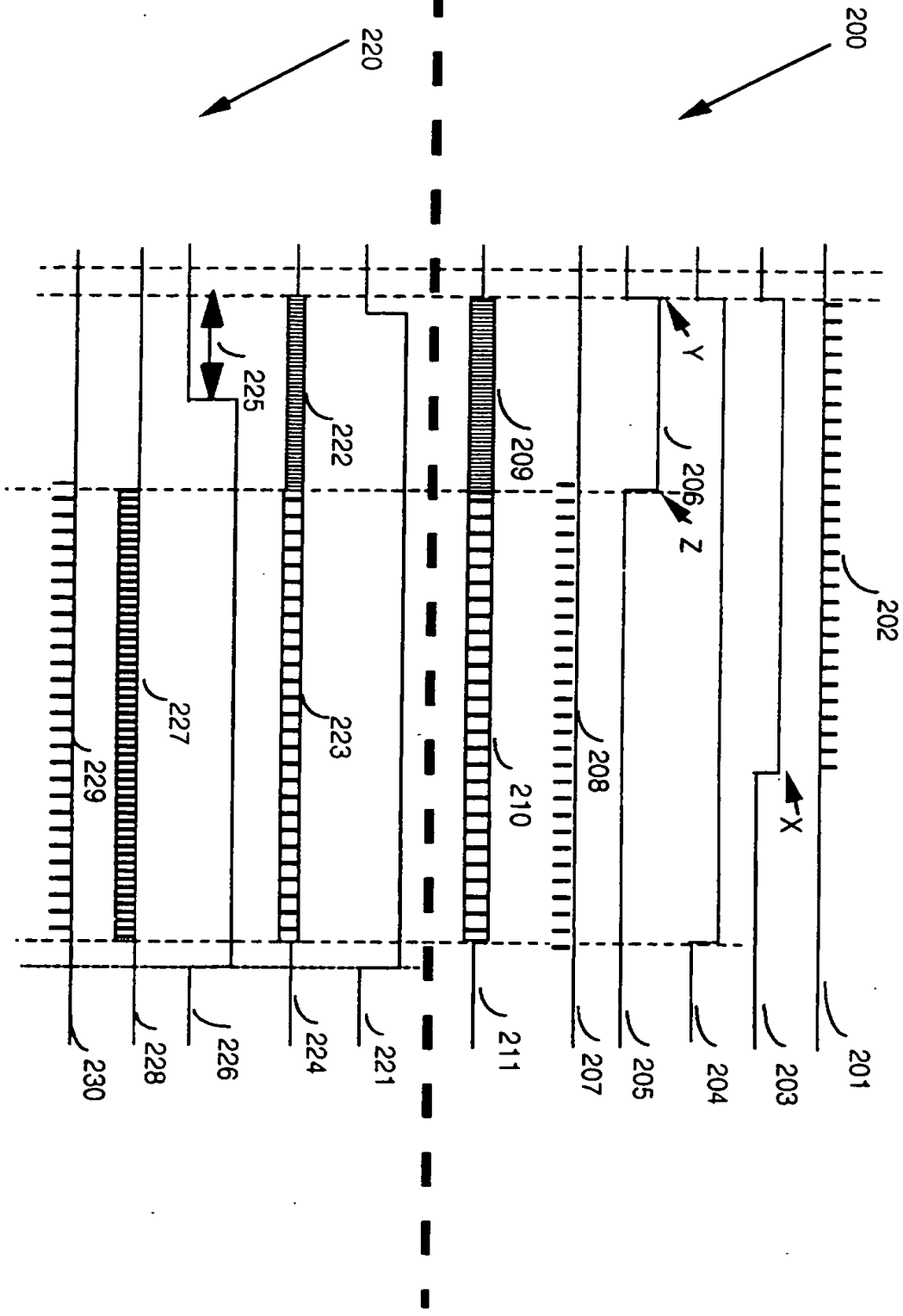
200
220
202
201
203
204
205
207
208
210
211
209
206
222
223
224
221
225
227
229
226
228
230
X
Y
Z

FIG. 4

APPARATUS AND METHOD FOR CONNECTING COMMUNICATIONS NETWORKS

Field of the Invention

This invention relates to a method for interfacing between local-area network and a radio communications system. The invention is applicable to, Electronic Industries Association recommended standard RS-485 and data radio communications systems.

Background of the Invention

An Electronic Industries Association (EIA) recommended standard RS-485 is a standard for electrical characteristics of generators and receivers for use in balanced digital multipoint systems. Systems that operate within the guideline of the RS-485 standard include multiple generators and receivers that may be attached to a common interconnecting two wire cable. A local-area network that meets the RS-485 standard is relatively straightforward to design. The data signalling rate within the standard may be up to 10 megabits/second, and the distance between generators or receivers, e.g. data terminals, may be up to 340 meters. The terminals are connected in parallel with one pair of wires there being no control lines.

RS232 is a standard for connecting and controlling via protocols digital equipment such as terminals and computer to another digital equipment via modems. In the RS232 standard control lines for controlling the data flow are provided. The control lines are : Request To Send (RTS), Clear To Send (CTS) Carrier Detected (CD), Data Set Ready (DSR) and Data Terminal Ready (DTS). RTS and CTS control lines are needed when, for example, a terminal is requested from a main computer to send data. The terminal is connected to a modem and sends RTS command to a modem. The modem starts to synchronise with the modem connected to the main computer. When the modems establish communication the modem that is connected to terminal sends a CTS command to the terminal and then the terminal starts to transmit data to the main computer.

Digital equipment that needs to control data flow cannot be connected to RS485 networks because control lines are not provided. Therefore, connecting a RS-485 network to another network is not possible.

This invention seeks to provide a method and apparatus for interfacing between RS485 local-area network to other networks which mitigates the above mentioned disadvantages.

Summary of the Invention

According to the to a first aspect of the invention there is provided an apparatus for connecting via a communication system, having at least one communication device, an RS485 local-area network to at least one other network. The apparatus includes: a modem for transmitting and receiving data messages and an interface for interfacing the modem to the communication system. The interface includes : a first input and a first output for, in use coupling the interface to the modem, a second input and second output for coupling the interface to the communication device, a means to generate a request to send message to the modem and a means to simulate a clear to send message for the modem.

By use of the present invention an RS485 network can be connected to an other network via a communication system such as radio communication system, telephony communication system, infra red communication system or other communication system because the clear to send command that is required for modem communication is simulated.

Preferably, the interface includes an input driver having an input and an output, and an output driver having an input and an output, wherein the input of the input driver and the output of the output driver are coupled to an input of the RS485 local-area network, a switch operably coupled to the output of the output driver and to the input of the input driver having an output operably coupled to a control unit and an input and a control line operably coupled to the modem and the control unit for generating a request to send message and to simulate a clear to send message which control unit having a first output for controlling the communication device and a second output operably coupled to the modem for sending data messages.

In this manner, the means to generate a request to send message and the means to simulate a clear to send message includes an input

buffer having an input for receiving data messages from the RS485 local-area network, a stack for storing the received messages, a delay unit for delaying the transferring of the data messages for a certain period of time and an output buffer for transferring the data messages to the modem.

In the preferred embodiment of the invention the communication system is a radio communication system and the communication device is a radio transmitter.

In the preferred embodiment of the invention the communication system is a telephony communication system having telephone lines and the communication device is a telephone.

In the preferred embodiment of the invention the communication system is a telephony communication system having telephone lines and the communication device is a dial-up modem.

In a second aspect of the present invention a method for connecting via a communication system, having at least one communication device, an RS485 local-area network to at least one other network is provided. The RS485 network includes an apparatus having an interface unit and a modem. The method of connecting includes the steps of: monitoring the RS485 local-area network for messages destined for the at least one other network, simulating a clear to send message to the modem and sending via the communication system a data messages from one of the RS485 local-area network to the at least one other network.

In this manner, the step of simulating a clear to send message includes the steps of: generating a request to send (RTS) command for the modem and delaying the data messages for a constant period of time.

Preferably, the interface unit includes means for monitoring and controlling an operating mode of the communication device and the step of sending via communication system data messages further includes the steps of: sending to the communication device a connect command for changing the operating mode of the communication device to a connect mode, starting a time delay and sending data messages at an end of the time delay to the network.

In the preferred embodiment of the invention the communication system is a radio communication system and the communication device is a radio transmitter.

In the preferred embodiment of the invention the communication system is a telephony communication system having telephone lines and the communication device is a telephone

A preferred embodiment of the invention will now be described by way of example only, with reference to the drawing.

Brief Description of the Drawings

FIG. 1 is a block diagram of a radio communication system connected to local-area network according to a preferred embodiment of the invention;

FIG. 2 is a block diagram of a modem having an electronic circuit for interpreting binary signals to a radio transceiver controls according to a preferred embodiment of the invention;

FIG. 3 is a flow chart showing a method for interfacing between a local-area network and a radio communications system according to a preferred embodiment of the invention; and

FIG. 4 is a timing diagram of data messages transmitted between a transmitting side of a first local area network to the receiving side of a second local area network in a radio communication system according to a preferred embodiment of the invention.

Detailed Description of the Drawings

Referring firstly to FIG. 1, a communications system 1 comprises a plurality of sub-networks linked together. The system includes local-area networks 11 and 21 and a point to multipoint data radio communications system comprising radio stations 12, 19 and 18.

Each local-area network 11, 21 includes computer terminals 10, 23 and printers 22, the interaction between which is governed by a LAN protocol such as AppleTalk and Ethernet. The local-area networks 11, 21 are also connected to a respective one of the radio stations 12, 19 and 18.

The radio stations are nominally identical and therefore, only radio station 12 will be described in detail. It can be seen from FIG. 1 that radio station 12 includes an apparatus 13 which includes a modem 15 by means of which the radio station 12 communicates with the local-area network 11 and an interface 14 the function of which will be later described. The radio station 12 also includes a radio transmitter 16 connected to the modem 15 and an antenna. The radio station 19 also includes a radio transmitter 20 and an apparatus 26 which includes a modem 24 and an interface 25.

Having given a general system overview, the apparatus 13 will now be described in greater detail with reference to FIG. 2.

Apparatus 13 has a two wire input 33 which connects to a port in the local-area network 11. The two wire input is connected to an input driver 34. The input driver 34 is connected to a switch 36. An output from the switch 36 is connected to an input of an input buffer 46 of a control unit 32.

The input buffer 46 has three outputs. The first output is a buffer full flag 53 connected to a command generator 41 and to a delay unit 42. The second output is a buffer empty flag 52 connected to the command generator 41 and the third output is connected to a stack 44. An output 47 from the command generator 41 is input to the radio transmitter 16.

An output from the delay unit 42 is connected to a switch 43. The switch 43 makes and breaks a connection between two units 45 and 40.

Buffer 46 is connected to the stack 44 which in turn is connected to an output buffer 45. The output buffer 45 is in turn connected to a modem transmitting unit 40 the connection being made and broken by the switch 43 described earlier.

The modem transmitting unit 40 is connected by connection 48 to the radio transmitter 16.

The radio transmitter 16 has an output 49 which is a channel monitor (CM) command line. This is connected to a modem receiver 39. The modem receiver 39 has two outputs 37 and 38. Output 38 is connected to the switch 36 and provides a control signal path allowing the modem receiver 39 to control the switch 36 in a manner to be later described. Output 37 is connected to an output driver 35 via the switch 36. The switch 36 prevents the modem 15 receiving and transmitting messages at the same time.

The way in which messages are transmitted from local-area network 11 to the other networks will now be described with reference to FIG. 4.

A transmitting side 200 timing diagram includes several graphs showing activities taking place from the moment that a stream of data messages 202 is received on the two line input 33. The transmitting side timing diagram includes the followings graphs: a starting of transmission graph 201, an input buffer graph 203, a push to talk (PTT) graph 204, a delay unit graph 205, a stack status graph 207 and a transmitted audio from the modem to the radio transceiver graph 211.

A receiving side timing diagram 220 shows the activities taking place from the moment that a stream of data messages 202 is received on the receiving side.

The receiving side timing diagram includes the followings graphs: a channel monitor (CM) graph 221, a receiving audio graph 224, a carrier detect (CD) status graph 226, a detected data levels graph 228 and a detected data in RS485 level graph 230.

Having given a general overview on the timing diagram, the system operation will now described in details with references to FIGs. 1,2 and 4.

Firstly, the transmitting side 200 will be described. A stream of messages 202, as it is shown in graph 201, destined for network 21 for example, will be transmitted by the radio station 12. The message stream 202 is received on the two line input 33 and is passed by the input driver 34 and switch 36 to input buffer 46. The input buffer 46 has a capacity to store one message only. In essence the operation that is described above is that the computer terminal 10 sends a transmit data (TD) command to the modem 15 in the sense that the modem 15 receives a stream of data 202 that is to be transmitted.

When the input buffer 46 is full, the buffer full flag 53 is turned to "on" state, as it is shown in graph 203. The delay unit 42 is responsive to the buffer full flag 53, after one message, to open the switch 43, as shown in graph 205. The commands generator 41 is also responsive to the buffer full flag 53 to generate a push-to-talk (PTT) command to the radio-transceiver 16, as shown in graph 204, and the radio transceiver then starts to transmit to establish communication with the radio station. The point marked "Y" on graph 205 is a generation of a request to send command (RTS). In modem terms RTS command was received by the modem 15.

The modem 15 starts to send a training sequence 209 to synchronise the modem in the network 21, as shown in graph 211. The delay unit 42 then counts for approximately 10 seconds 206, as is shown in graph 205, and the messages 208 are loaded from the buffer 46 to the stack 44 as shown in graph 207. From the stack 44 the messages are passed to the output buffer 45. When the delay unit 42 stops counting the switch 43 is then closed and the messages 210 are passed to the modem transmitter 40, as is shown in graph 211. The point marked "Z" on graph 205 is the simulation of a clear to send command (CTS). In modem terms a CTS message was initiated, showing that the modem 15 is ready to transmit data messages. The modem 15 starts to transmit the messages 210 as shown in graph 211.

The modem operation described in detail above involves a "mimicking" of normal modem RTS - CTS operation in which a sending modem sends an RTS message and then awaits a CTS message from the remote modem.

The modem transmitter 40 then transmits the messages to the transmitter 16 from whence they are transmitted to the radio station 19.

When the last message has been transmitted, the buffer empty flag 52 turns to "on" state and the buffer full flag will turn to "off" state at point dotted X on graph 203. The delay unit 42 will open the switch 43 after a certain delay, for example the time it would take 1.5 characters to enter the buffer, and then break the connection between the output buffer 45 and the modem transmitter 40. The command generator 41 then stops sending a PTT command to the transceiver 16.

The way in which the receiving side 220 will handle the transmitted messages will now be described.

When the transceiver 16 starts to receive the training sequence 209 from the modem of the radio station 12, as shown in graph 224, on the output 49, the modem channel monitor (CM) command line is turned to "on" state as shown in graph 221. The modem 24 starts to synchronise with the modem 15 by recovery of the clock 225 reference of modem 15 from the training sequence 209 and by setting is own clock to match modem 15 clock. The modem 24 then turns the CD command to "on" state as shown in graph 226, which indicates that the modem 24 is ready to receive data. The received message 223 is than passed through output 50 to the modem receiver 39. The switch 36 is responsive to the voltage level on output 38 to allow the modem 15 to transfer the received messages to the network and to prevent any new messages from the network being transmitted by the modem. The modem receiver 39 detects the received messages as shown in graph 228. Detected messages 227, as shown in graph 228, are passed by the modem receiver 39 and via the switch 36 to the output driver 35. From the output driver 35 they are placed onto the network via the wires 33 as is shown in graph 230.

The local-area network according to the preferred embodiment of the invention is typically a network that is based on the Open System Interconnection (OSI) model. The OSI model has seven layers. The first layer is the physical layer wherein an electrical and a mechanical connection of the data device is defined. RS485 is one of the standards for those layers. The others layers, that is to say a link layer, a network layer,

a transport layer, a session layer, a presentation layer and an application layer will not be discussed here.

Referring now to FIG. 3, a flow chart showing a method for interfacing between a local-area network and a radio communications system according to a preferred embodiment of the invention is shown.

The method starts with initialisation of the apparatus 13, step 100, and waiting for receiving data messages from the local-area network in step 101.

When data messages from the RS485 local-area network are received by the apparatus 13 the input driver 34 converts the data messages to digital signals, step 102 and control commands are created for the apparatus 13 and the radio transmitter 16.

The process of creation includes the steps of waiting for the input buffer 46 of the control unit 32 to be full, as in step 103; checking the radio transmitter operational mode as in step 104; and generating RTS command for the modem 15, as in step 105.

In response to a RTS command the delay unit 42 starts a time delay, step 106, and the radio transmitter 16 push to talk (PTT) command is issued, sending to the radio transmitter 16 a PTT command for changing the operating mode of the radio transmitter 16 to transmit mode, step 106.

In a next step, 107, the modem 15 sends a training symbols to the modem 24 and simulates the CTS command, step 109. The delay unit 42 stops the time delay after a constant period of time, for example 10 milli-seconds, step 110.

If the input buffer 46 is not empty, as in step 111, the data messages are moved to the stack 44 and from the stack 44 to the output buffer 45, as in step 112. A next step, step 113 involves sending over the air of the data messages at the end of the constant period of time delay.

If the input buffer 46 is empty, for example for more than the time that it would take 1.5 character to be received by the modem 15, as in step 111, the modem 15 stops the radio transceiver 16 transmitting by turning the PTT off, as in step 114. If the input buffer is not empty then the steps 111 to 113 are repeated.

The method of interfacing enables the connection via two wires or four wires digital equipment to a radio modem communication system and to control the receiving and the transmitting of a data messages without the use of an extra control lines.

In alternative embodiments of the invention the communication system can be a telephony system, a micro-wave system, a fiber-optic system or satellite system. The way that the modem establishes communication with the other modem is different from system to system but the way of "mimicking" the RTS and the CTS is the same in all of the systems. For example in telephony system after RTS command is initiated by the modem, the modem than dials to make connection to the other modem using a telephone or a dial-up modem.

Claims

1. An apparatus for connecting via a communication system, having at least one communication device, an RS485 local-area network to at least one other network comprising:

a modem for transmitting and receiving data messages; and

an interface for interfacing the modem to the communication system which interface including :

a first input and a first output for, in use coupling the interface to the modem;

a second input and second output for coupling the interface to the communication device;

a means to generate a request to send message to the modem ; and a means to simulate a clear to send message for the modem.

2. . The apparatus according to claim 1, wherein the interface comprises:

an input driver having an input and an output; and

an output driver having an input and an output, wherein the input of the input driver and the output of the output driver are coupled to an input of the RS485 local-area network;

a switch operably coupled to the output of the output driver and to the input of the input driver having an output operably coupled to a control unit and an input and a control line operably coupled to the modem; and

the control unit for generating a request to send message and to simulate a clear to send message which control unit having a first output for controlling the communication device and a second output operably coupled to the modem for sending data messages.

3. The apparatus according to claim 1 or 2 wherein the means to generate a request to send message and the means to simulate a clear to send message comprises:

an input buffer having an input for receiving data messages from the RS485 local-area network;

a stack for storing the received messages;

a delay unit for delaying the transferring of the data messages for a certain period of time ; and

an output buffer for transferring the data messages to the modem.

4. The apparatus according to any one of claims 1 to 3 wherein the communication system is a radio communication system and the communication device is a radio transmitter.

5. The apparatus according to any one of claims 1 to 3 wherein the communication system is a telephony communication system having telephone lines and the communication device is a telephone.

6. The apparatus according to any one of claims 1 to 3 wherein the communication system is a telephony communication system having telephone lines and the communication device is a dial-up modem.

7. A method for connecting via a communication system, having at least one communication device, an RS485 local-area network to at least one other network, which RS485 network includes an apparatus having an interface unit and a modem;

the method of connecting comprising the steps of:

monitoring the RS485 local-area network for messages destined for the at least one other network;

simulating a clear to send to the modem; and

sending via the communication system a data messages from one of the RS485 local-area network to the at least one other network.

8. The method according to claim 7, wherein the step of simulating a clear to send message comprises the steps of:

generating a request to send (RTS) command for the modem; and

delaying the data messages for a constant period of time.

9. The method according to claim 7 and 8, wherein the interface unit includes means for monitoring and controlling an operating mode of the communication device, and the step of sending via communication system data messages further comprises the steps of:

sending to the communication device a connect command for changing the operating mode of the communication device to a connect mode;

starting a time delay; and

sending data messages at an end of the time delay to the network.

10. The method according to any one of claims 7 to 9, wherein the communication system is a radio communication system and the communication device is a radio transmitter.

11. The method according to any one of claims 7 to 9 wherein the communication system is a telephony communication system having telephone lines and the communication device is a telephone.

The Patent Office

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Application No: GB 9617113.7 **Examiner:** Keith Williams
Claims searched: 1-11 **Date of search:** 12 November 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H4P (PPA, PPEC)

Int Cl (Ed.6): H04L 12/46, 12/66, 29/06, 29/10

Other: online WPI, INSPEC

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB 2267801 A Leandre - see Fig. 1	1,7

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.